Doc: PGD 25 (26370) WC
March 2025

BUREAU OF INDIAN STANDARDS
DRAFT FOR COMMENTS ONLY
(Not to be reproduced without permission of BIS or used as Standard)

भारतीय मानक मसौदा

कोण गेज ब्लॉक – विशिष्टि

(IS 6231 *का पहला पुनरीक्षण*)

Draft Indian Standard

Angle Gauge Blocks — Specification

(*First Revision of* IS 6231)

ICS 17.040.10

Engineering Metrology Sectional Committee, PGD 25	Last date for receipt of comment is: **20 May 2025**

FOREWARD

(*Formal clauses will be added later on*)

The angle gauge blocks can be used either individually or be wrung together to form composite angles. Annex A gives examples for building angles using angle gauge blocks alone and angle gauge blocks along with precision square block.

This standard was first published in 1971. This first revision has been brought out to keep pace with the latest technological developments and international practices. In this revision the following major changes have been made:

a) Methods for calibration of angle gauge blocks have been added,
b) Material and tolerances of the angle gauge block have been updated, and
c) Reference clause has been updated.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*).’ The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Draft Indian Standard

ANGLE GAUGE BLOCKS — SPECIFICATION

(*First Revision*)

1 SCOPE

This standard specifies the requirements for angle gauge blocks.

NOTE—These angle gauge blocks together with the square block may be used to obtain any angle between 0° and 360° in steps of 6 s.

2 REFERENCES

The standards listed below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below.

IS No	*Title*
IS 3073 : 1967	Assessment of surface roughness
IS 3748 : 2022/ ISO 4957 : 2018	Tool Steels - Specification
ISO/IEC Guide 98-1:2024	Guide to the expression of uncertainty in measurement Part 1: Introduction

3 MATERIAL

The material of the angle gauge blocks shall be suitable gauge steel or tungsten carbide which has the properties of ageing stability in dimensions and wear resistance. The following grades of steels as per IS 3748 are considered as suitable steel.

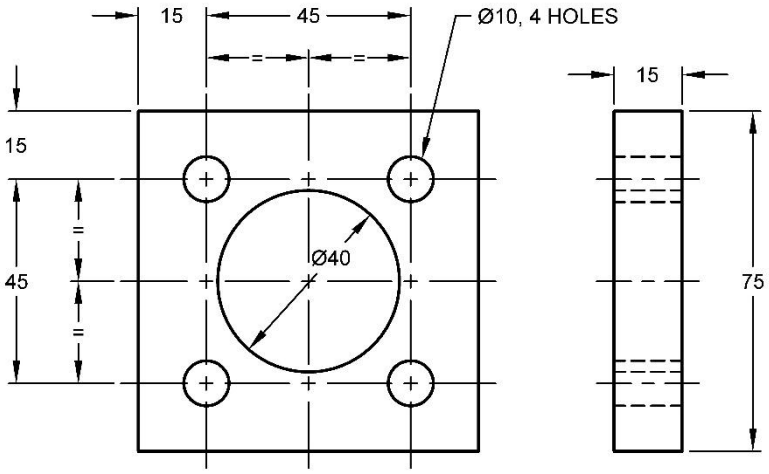
Sl No.	*Designation*
i)	X153CrMoV12
ii)	X210Cr12
iii)	X210CrW12

The working surfaces shall be hardened to not less than 800 HV.

4 DIMENSIONS

4.1 Precision Square Block

The dimensions of precision square block shall be as given in Fig. 1.



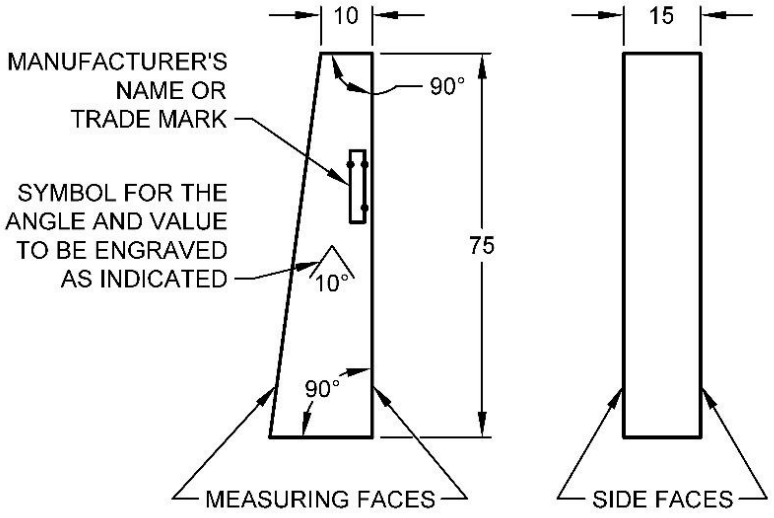
All dimensions in millimeters

FIG. 1 PRECISION SQUARE BLOCK

NOTE — The precision square block is provided with a set of angle gauge blocks for gauging a right angle.

4.2 Angle Gauge Blocks

The dimensions of angle gauge blocks shall be as given in Fig. 2.



All dimensions in millimeters

FIG. 2 ANGLE GAUGE BLOCK

4.3 The recommended sets of angle gauge blocks are as under and shall be designated as Set A:

Set A (12 +1) —
- One each of 1, 3, 9, 27 and 41 degrees
- One each of 1, 3, 9 and 27 minutes
- One each of 6, 18 and 30 s

4.4 An alternative set of angle gauge blocks (designated as Set B) is given below:

Set B (14 +1) —
- One each of 1, 3, 5, 15, 30 and 45 degrees
- One each of 1, 3, 5, 20 and 30 minutes
- One each of 6, 12 and 30 s

NOTE — The above set along with the square block enables any angle to be built up to 6 s. The tolerance for a combination of various gauges should be within the square root of the sum of the squares of the individual gauge tolerances.

5 TOLERANCES

The tolerances of this standard shall be given as:

Sl No.	*Quality*	*Limiting value or Maximum Permissible error*
i)	The actual angle of each gauge including each interior angle of the precision square block shall agree with its nominal size	±2 s of arc at laboratory grade and ±5 s of arc at workshop grade
ii)	The measuring faces shall be flat	0.25 µm
iii)	The measuring faces shall be parallel transversely (i.e. each point on a line drawn across a measuring face will be at the same vertical level)	1.0 µm
iv)	The side faces shall be ground flat	2.5 µm
v)	The measuring faces shall be square to the side faces	± 30 s or 2.5 µm over the width 15 mm of measuring face
vi)	The surface roughness 'R_a' of the measuring faces shall be	0.1 µm, when tested in accordance with IS 3073

6 GENERAL REQUIREMENTS

6.1 The angle gauge blocks shall be suitably stabilized by any one of the established stabilizing processes.

6.2 The measuring faces shall be lapped flat to give a good wringing contact. The side faces shall be finely ground or lapped. The surface roughness of the gauging faces shall conform to the requirements given in **5(vi)**. The gauging faces shall be free from corrosion marks, burrs or such other defects as would inhibit the satisfactory functioning of the surfaces. The edges shall be chamfered within 0.2 mm.

6.3 A precision square block having four sides lapped for wringing is provided for use with the angle gauge blocks.

6.4 A certificate giving the deviations of the angles of individual gauge blocks from their nominal angle shall be issued with each set.

6.5 Calibration of angle gauge blocks shall be carried out as per Annex B or any established method. The method selected for the calibration shall be based on the uncertainty of measurement having 50% of acceptable angular tolerance or at least within the acceptable angular tolerance.

7 DESIGNATION

7.1 A set of angle gauge blocks shall be designated by the name, the set to which it belongs and the number of this standard.

Example:

Angle Gauge Block Set A, IS 6231

7.2 The individual angle gauge blocks shall be designated by the nominal included angle and the number of this standard.

Example:

Angle Gauge Block 3°, IS 6231

8 MARKING

8.1 The angle gauge blocks shall be marked with the following as shown in Fig. 2:

a) Nominal included angle,
b) Symbol for the angle i.e, 27°, 9’, 6”, and
c) Manufacturer’s name or trade-mark.

8.2 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the standard mark.

9 PRESERVATION AND PACKING

9.1 All angle gauge blocks shall be protected against climatic conditions by being covered with a hard drying lanolin, or other suitable non-corrosive preparation and shall be securely wrapped in waxed paper.

9.2 Sets of angle gauge blocks shall be packed in special boxes provided for the purpose, each set consisting of 13 or 15 gauge blocks as the case may be.

ANNEX A
(*Foreward*)

EXAMPLES OF BUILDING ANGLES

A-1 EXAMPLES OF BUILDING ANGLES USING ANGLE GAUGE BLOCKS

Example 1:

To build an angle: 24° 10' 18"

a) Using set A (*see* Fig. 3)

Gauge blocks required to obtain — 24° = 27° − 3°

10' = 9' + 1'

and 18" = 18"

Therefore, the required angle is obtained by the combination of:

(27° − 3°) + (9' + 1') + 18"

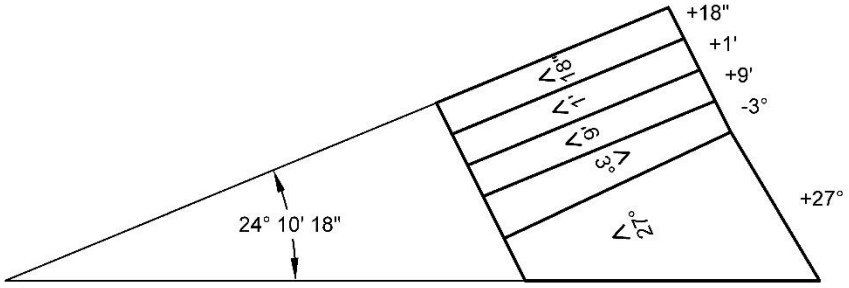


FIG. 3 BUILDING ANGLES USING ANGLE GAUGE BLOCKS

b) USING set B

Gauge blocks required to obtain — 24° = 30° − 5° − 1°

10' = 30' − 20'

and 18" = 12" + 6"

Hence the required angle is obtained by the combination:

(30° − 5° − 1°) + (30’ − 20’) + (12” + 6”)

Example 2:

To build an angle: 29° 50' 9"

a) Using set A

The fraction of a degree exceeds 40', therefore the angle may be written as:

$$30° - 10' + 9'$$

Gauge blocks required to build up the required angle in this case are:

$$30° = 27° + 3°$$

$$10' = 9' + 1'$$

and 9"= 6" (The nearest gauge block that can be used with an error of +3").

Therefore, the angle = $(27° + 3°) - (9' + 1') + 6"$
with an error of +3 sec.

b) Using set B

$$29° = 30° - 1°$$

$$50' = 30' + 20'$$

9" = 6" (The nearest gauge block with an error of +3").

Therefore, the angle = $(30° - 1°) + (30' + 20') + 6"$
with an error of + 3".

NOTE — Any angle beyond 81° in the case of Set A and 90° in the case of Set B, can be obtained by suitably using the precision square block provided along with each set.

A-2 EXAMPLES OF BUILDING ANGLES USING ANGLE GAUGE BLOCKS ALONG WITH PRECISION SQUARE BLOCK

A B C D is the precision square block. A B E F, the angle gauge combination to give an angle x, is wrung on to the square block A B C D.

Referring to figure, if we draw normal 1, 2, 3, 4 and 5 to faces AB, BC, CD, DA and FE, it is seen that proceeding in a clock-wise direction the angles between normal 5 and 1 is x, between 5 and 2 it is (90 + x), between 5 and 3, it is (180 + x) and between 5 and 4 the angle being (270 + x). Since it is possible to build angle x in increments of 6 s, it is clear that any angle from 0 to 360° in steps of 6 sec. can be built up using the angle gauge blocks and the precision square block.

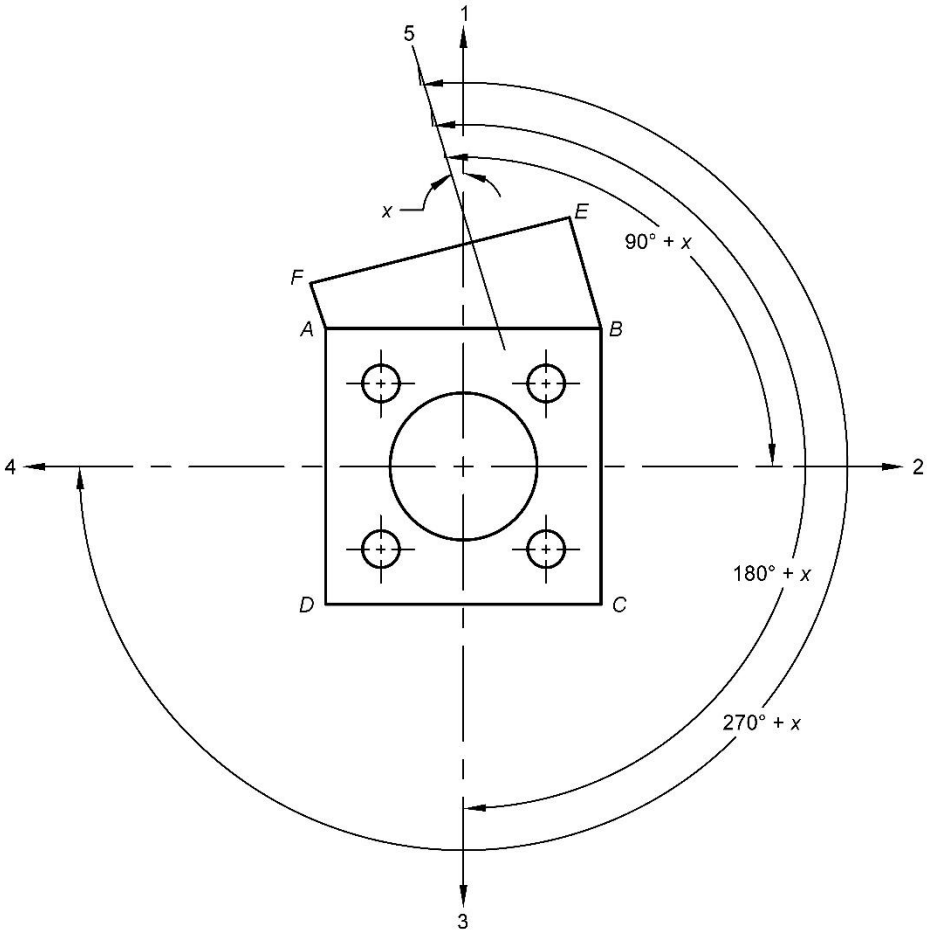


FIG. 4 USE OF PRECISION SQUARE BLOCK

Example 1:

Angle required 121° 15' 27"

The angle can be written as:

90° + 31° 15' 27"

Using angle gauge blocks the angle 31° 15' 27" is built. This combination is then wrung on to the square block and the required angle 121° 15' 27" is obtained.

Referring to Fig. 4 the angle x in this case will be 31° 15' 27" and hence the angle between normal 5 and 2 in clockwise direction will give the required angle 121° 15' 27".

Example 2:

Angle required 306° 18' 42"

This angle can be written as:

270° + 36° 18' 42"

The angle 36° 18' 42" is built up using the angle gauge blocks and the same in combination with the square block will give the required angle.

Referring to figure 4, the angle x in this case will be 36° 18' 42" and the angle between the normal 5 and 4 in clockwise direction will give the required angle 306° 18' 42".

ANNEX B
(*Clause* 6.5)

METHODS FOR CALIBRATION OF ANGLE GAUGE BLOCKS

B-1 ENVIRONMENTAL CONDITIONS

The calibration environment shall be maintained at a temperature of 20°C ± 2°C, for a minimum period of two hours before calibration.

B-2 EQUIPMENT

Calibration shall be performed using an autocollimator with precision indexing table, or a rotary table with electronic comparator, or an electronic comparator and combination of slip gauges.

B-3 PRINCIPLE, PARAMETER AND METHOD

B-3.1 Principle — Comparison of angle readings with reference standard.

B-3.2 Parameter — Angular accuracy shall be checked.

B-3.3 Method

B-3.3.1 *Calibration of Angle Gauge Blocks by using Autocollimator with Precision Indexing Table*

In this method of calibration, place the angle gauge block close to the center of the indexing table with suitable fixture to match the height with approximate center of the autocollimator barrel, then align the angle gauge block with the autocollimator incident light rays, set autocollimator reading to zero. Index the indexing table to nominal angle specified on the angle gauge block and note down the autocollimator reading which gives error in the angle gauge blocks. Calculate the calibrated angle of the angle gauge block by adding the angle error.

B-3.3.2 *Calibration of Angle Gauge Blocks by using Rotary Table with Electronic Comparator*

In this method of calibration mount the angle gauge block close to the center of the Rotary table, align one of the functional faces of the angle gauge block in the horizontal direction using electronic comparator, and rotate the rotary table in the counter clock wise direction till the other functional face becomes horizontal, align this functional face in the horizontal direction using electronic probe lever type by adjusting rotary table, note down the rotary table reading, which gives the angle between the faces.

B-3.3.3 *Calibration of Angle Gauge Blocks by Trigonometric Method*

In this method of calibration, a fixture-like use of a comparator stands (*see* Fig. 5), place the combination of slip gauges on the angle gauge block and measure the deviation between the angle gauge and slip gauge for the calculated distance. Convert the measured reading, which is in linear unit by using the suitable formula [i.e. angle error = $\tan^{-1}$(electronic comparator reading in mm/calculated distance in mm)], which gives the angle error of the particular angle gauge block and calculate the calibrated angle of the angle gauge block by adding the angle error.

FIG. 5 CALIBRATION OF ANGLE GAUGE USING COMPARATOR STAND

B-4 REPORTING OF RESULT

Calibration of angle gauge blocks should be reported in the following format:

Sl No.	Nominal Angle	Calibrated Angle
1.		
2.		
3.		

B-5 MEASUREMENT UNCERTAINTY

B-5.1 General

The estimation of the measurement uncertainty should follow the procedures and formulae of ISO/IEC Guide 98-1.

B-5.2 Estimation of Expanded Measurement Uncertainty

Uncertainty shall be calculated for the result of the calibration of the angle gauge blocks. For random uncertainty (Type A) contribution at least 5 measurements shall be taken. For systematic uncertainty (Type B) contribution, the following uncertainty contributions shall be considered (but not be limited to):

a) Uncertainty of instrument / equipment / reference artifact used;
b) Error of instrument / equipment / reference artifact used;
c) Resolution of instrument /equipment if applicable;
d) Form error of angle gauge block;
e) Uncertainty of temperature measuring device (in case of trigonometry method); and
f) Uncertainty in thermal expansion coefficient (in case of trigonometry method).

Calculate the standard measurement uncertainty for Type A and Type B contributors, calculate combined standard uncertainty and calculate expanded uncertainty by considering the coverage factor.

B-6 ACCEPTANCE CRITERIA

As per specifications given in **5**.